60/462,556

60462556 .041103

LENS ABSORBED WATER REMOVAL SYSTEM

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Background of the Invention

This invention relates to an immersion lithography system, such as described in WO99/49504, having a liquid supplied into the space between a workpiece such as a wafer and the last-stage optical element such as a lens of the optical system for projecting the image of a reticle on the workpiece. The liquid thus supplied improves the performance of the optical system and the quality of the exposure.

The supplied fluid may be water for light with wavelength of 193nm, for example. For other wavelengths, different liquids may be necessary. Because the last-stage optical element is exposed to the liquid, there is a chance that some of the liquid will be absorbed by the element. In particular, if the last-stage optical element is a lens, calcium fluoride is a common lens material for lithography systems and is a hygroscopic material. In other words, the last-stage optical element in an immersion lithography system is likely to absorb water from the surrounding environment.

The absorbed water may cause several problems. Firstly, it may degrade the image projected by the lens by changing the refractive properties of the lens element, or by causing swelling of the lens and changing the geometry of the lens. Secondly, it may cause long-term degradation of the lens due to chemical effects.

It is therefore an object of this invention to provide a system and method for periodically removing the water from the lens to prevent the absorbed water level from reaching a critical level to cause degradation of the image and to prevent long-term damage to the lens.

Summary of the Invention

Figs. 1 and 2 show two steps taken by a system embodying this invention. In the first step, as shown in Fig. 1, a pool of water is shown between the bottom of a lens (representing the last-stage optical element of an immersion lithography system) and a

wafer (representing an example of workpiece for having an image projected thereonto). The wafer is being exposed under normal exposure conditions and then removed from underneath the lens. In the next step, as shown in Fig. 2, the bottom of the lens is brought into contact with an absorbed liquid removal system. This system can be either a portable system that is positioned under the lens or a fixed system to which the lens is moved. In the case of a portable system, it can be placed on the wafer stage, either in place of the wafer or the wafer chuck.

The system itself can have several embodiments. As a first example, the system contains a liquid with a strong affinity for the immersion liquid absorbed by the lens. In the case of water as an immersion liquid, a removal system may contain ethanol that has a strong affinity. Any removal liquid can be used provided it has an affinity for the liquid to be removed and does not damage the lens element or coating of the lens. The bottom of the lens may be caused to soak in the liquid for a period of time to reduce the absorbed liquid level. The removal system is removed thereafter and the lens is ready to be exposed to water.

As another example, the system may contain a heat generating system and/or a vacuum device. The combination of heat and/or vacuum on the surface of the lens causes absorbed water to undergo a phase change to vapor, or to evaporate from the surface. The reduction in water density on the surface of the lens draws water that is absorbed more deeply in the lens to the surface.

Water removal systems of other types may also be used for the purpose of this invention.